

***Engaeus* Erichson (Decapoda: Parastacidae) capture using two versions of a Norrocky trap**

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ABSTRACT

Burrowing crayfish are notoriously difficult to sample owing to their cryptic nature and subterranean habitat. The most commonly employed sampling method is burrow excavation but it is labour-intensive, destroys the burrow and hence is not repeatable. Consequently, non-destructive sampling methods are more desirable, especially for species of conservation significance, but such methods remain poorly investigated.

Capture effectiveness of the original Norrocky Trap (Norrocky 1984) and a design modified specifically to target crayfish of the genus *Engaeus* Erichson (Decapoda: Parastacidae) were assessed. The modified design had a smaller diameter, used different materials and housed a variation on the trapdoor design found in the Norrocky Trap. Traps were trialled in the Bunyip State Park and the Gippsland region of Victoria, south-eastern Australia where burrowing crayfish of the genus *Engaeus* are known to occur. Significantly higher capture rates resulted from the modified trap design, with several *Engaeus* species captured. Further refinements of this or similar trap designs have the potential to improve capture rate.

This work demonstrates that the modified Norrocky Trap is an effective method for *Engaeus* capture. We envisage the trap design will promote a broader use of non-destructive sampling methods for *Engaeus* and potentially other burrowing crayfish genera.

Key Words: non-destructive sampling, Norrocky Trap, *Engaeus*, Parastacidae

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Introduction

Burrowing crayfish of the genus *Engaeus* are rarely seen above ground. Their burrow systems can have multiple entrances and chambers (e.g. *Engaeus hemicirratulus* Horwitz and Richardson 1986) often occupied by more than one generation of crayfish (Horwitz 1990). Burrows are either connected to permanent water (e.g. surface water and/or water table) or have no connection to any water source instead being reliant on surface runoff (Horwitz and Richardson 1986).

As a result of their subterranean habitat and generally cryptic nature, surveying burrowing crayfish is difficult. The most common survey method is burrow excavation (Ridge *et al.* 2008) which can be effective at capture but is labour-intensive, destroys the burrow, can result in crayfish mortality and does not allow repeat sampling. In contrast, non-destructive methods allow repeat sampling, require less physical labour and reduce disturbance and mortality, which is particularly important for species of conservation significance and for ecological or behavioural studies that require crayfish recapture.

Non-destructive methods for burrowing crayfish capture include techniques that directly target burrows such as the Burrowing Crayfish Net (Welch and Eversole 2006), a recently described reversed pitfall trap (Hopper and Huryn 2012) and the Norrocky Trap (Norrocky 1984).

The Burrowing Crayfish Net is a piece of avian mist

netting, placed in a burrow entrance to entangle emerging or entering crayfish (Welch and Eversole 2006). The reversed pitfall trap is a modified funnel inserted into a hole in the bottom of a covered bucket which captures crayfish as they emerge from their burrows and fall into the surrounding bucket (Hopper and Huryn 2012). The Norrocky Trap (Norrocky 1984) is a pipe containing a one-way internal trapdoor that is placed into a crayfish burrow entrance to capture any exiting crayfish. The Norrocky Trap has previously been used in the United States (e.g. Norrocky 1984; Welch and Eversole 2006; Ridge *et al.* 2008). Less specific methods such as spot lighting (Hobbs 1981), plunging (Loughman 2010) and dip netting (Johnston and Robson 2009) have also been used to target aquatic species that are likely to have submerged burrow entrances.

As surface activity of the Australian burrowing crayfish *Engaeus* is limited and most do not inhabit surface waters, methods that target burrow entrances, such as traps and nets, are likely to be the most effective. Based on investigations of viable non-destructive sampling methods, we found a one way trapdoor design such as the Norrocky Trap (NT) showed the most potential for burrowing crayfish capture (Bryant *et al.* 2012). Preliminary trialling of the NT led us to develop a modified version of the Norrocky Trap with a smaller diameter to better suit the diameter of *Engaeus* burrows encountered in the study area (Figure 1).



Figure 1. *Engaeus hemicirratulus* burrow at Mount Worth State Park with keys indicating burrow diameter. Photo: Diane Crowther.

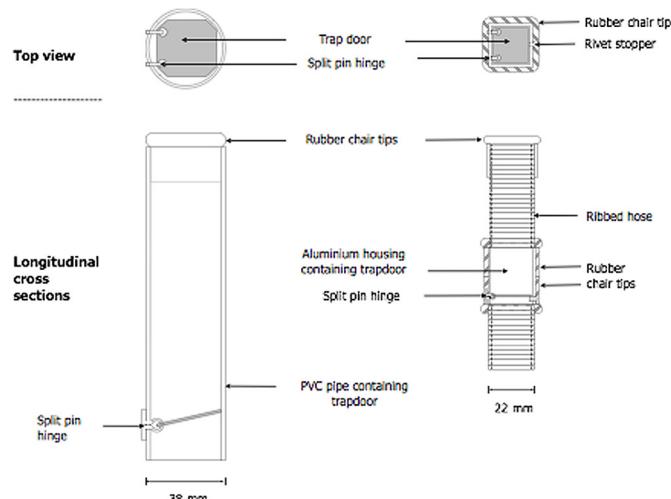


Figure 2. Trap design showing the Norrocky Trap (left) and the modified trap (right).



Figure 3. Traps deployed in pairs showing the Norrocky Trap (background) and the modified trap (foreground). Photo: Diane Crowther.

The original and modified Norrocky traps were trialled in the Bunyip State Park and the Gippsland region of Victoria, south-eastern Australia. South-eastern Australia is a biodiversity hotspot for crayfish of the family Parastacidae (Riek 1969; Crandall and Buhay 2008; Schultz *et al* 2009) and includes thirty-five species of small burrowing crayfish from the genus *Engaeus* (Horwitz 1990, 1994). Thirty-one of these species are considered short-range endemics (Horwitz 1994; Harvey 2002). The restricted distributions of many species and their vulnerability to habitat disturbance (Department of Sustainability 2003a, 2003b, 2009) highlights the need for effective non-destructive sampling methods.

Methods

Trap design

The NT used in the trials was constructed to the smaller of the two sizes specified by Norrocky (1984). The modified NT design had a smaller diameter, used different materials and housed a variation on the trapdoor design found in the NT.

The NT was constructed from PVC pipe (internal diameter 38 mm) with a 0.5 mm thick aluminium sheet trapdoor hinged approximately 20 mm above the base of the pipe (Figure 2). The trapdoor is hinged at a slight angle to ensure upward movement only. A rubber chair tip (32 mm internal diameter) was used to cap the open end of the pipe to prevent crayfish escape.

The modified NT trap was composed of aluminium trapdoor housing with a section of hose at each end. The central square aluminium tubing (30 mm × 25.4 mm × 1.2 mm) houses an aluminium sheet trapdoor (20 mm × 20 mm × 0.5 mm) that is hinged through the wall of the tubing using two split pins (Figure 2). A rivet is used as a stopper on the opposite wall to the hinge so the trapdoor can only open one way. A 25 mm diameter hole is punched out of the closed end of two rubber chair tips (28 mm internal diameter), which are stretched over each end of the trapdoor housing and joined using reinforced duct tape. The punched chair tips allow for two flexible, ribbed 'greywater' hose sections, (60–120 mm in length, 22 mm internal diameter) to be inserted at either end of the square trapdoor housing. The hose piece below the housing is inserted into burrow openings. An additional rubber chair tip is used to cap the hose piece above the trapdoor to prevent light penetration and crayfish escape. All materials were sourced from a major hardware store.

Capture effectiveness

Trapping trials took place in the late summer and autumn of 2011. As crayfish surface activity is thought to be largely nocturnal (Richardson and Swain 1980; Loughman 2010) traps were set in the mid- to late afternoon and retrieved the following morning. Traps were set in pairs of one NT and one modified trap (Figure 3) at burrow openings that showed signs of recent surface activity (e.g. moist or wet excavated mud pellets or soil). As it is impossible to delineate burrow system boundaries without destroying the burrows themselves, trap placement was based entirely

on evidence of recent activity. Removal of excavated material or addition of soil was sometimes necessary to securely seat the NT when the trap diameter was larger than the burrow opening. The modified traps were inserted directly into burrow entrances, occasionally requiring the excavated material to be moulded around the hosing to securely seat the trap.

Traps were set at six sites across three locations (Table 1) – one site in the Bunyip State Park (ten pairs of traps), three sites in the Mirboo North Regional Park and two sites in the Mount Worth State Park (thirty pairs of traps at each site). In total 160 trap pairs were set targeting areas where burrows were most prevalent (wet riparian zones to lower slopes).

Once retrieved, traps were examined by removing the rubber chair tip and inspecting the inside of the trap for evidence of crayfish activity or crayfish captures. Captured crayfish were removed from the modified trap by detaching the hosing above the trapdoor housing (Figure 4). Crayfish were identified to species using Horwitz (1990).

Analysis

Capture rates were calculated by dividing the number of crayfish captured by the number of traps set and expressed as a percentage. To test whether capture rates differed statistically between the two trap types a binomial proportion test (two-tailed with continuity correction) was performed using the R package version 2.15.2 (R Core Team 2012).

Results

Three species of *Engaeus* were captured, *Engaeus hemicirratulus* (Figure 5), *Engaeus quadrimanus* and *Engaeus phyllocercus*. A total of 15 individuals were captured with 14 of these captured in the modified trap. Overall capture rate was significantly higher for the modified trap (8.8%) compared to the NT (0.6%) ($P=0.001$) (Table 2). The highest individual capture rate for any site was 20.7% (6 individuals captured from 30 traps) at Mirboo North Regional Park Site 3.

Discussion

This work represents the first successful use of a one way trapdoor design for *Engaeus* capture and suggests that further investment in non-destructive sampling methods for this group of burrowing crayfish would be worthwhile. The focus of our work was to investigate trap designs for successful *Engaeus* capture and as such the specific

Table 1. Location of trap testing sites in the Bunyip State Park and Gippsland region, Victoria.

Location	Latitude (GDA94)	Longitude (GDA94)
Bunyip State Park Site 1	-37.9699	145.7364
Mirboo North Regional Park Site 1	-38.3710	146.1817
Mirboo North Regional Park Site 2	-38.4262	146.2420
Mirboo North Regional Park Site 3	-38.3693	146.2016
Mount Worth State Park Site 1	-38.2778	146.0100
Mount Worth State Park Site 2	-38.2821	146.0079



Figure 4. The modified trap with the hosing detached showing a captured *Engaeus*. Photo: Diane Crowther.



Figure 5. Captured *E. hemicirratulus* at Mount Worth State Park. Photo: Diane Crowther.

Table 2. Comparisons of burrowing crayfish capture rates from the Norrocky Trap and the modified trap.

Trap type	Total number of traps	Species (number captured)	Capture rate (%)
Norrocky Trap	160	<i>Engaeus quadrimanus</i> (1)	0.63
Modified trap	159 [#]	<i>Engaeus hemicirratulus</i> (4) <i>Engaeus phyllocercus</i> (4) <i>E. quadrimanus</i> (6)	8.8

[#] one trap was not recovered

influence of differences in trap design was not assessed. However, as the key differences between the two traps were trap diameter and materials, it is likely that either or both of these features contributed to the higher capture rate of the modified trap.

The diameter of the modified trap allowed easy insertion into burrow openings, creating an artificial extension to the burrow and directing emerging crayfish upward into the trap. In contrast, the NT had to be placed over most burrows owing to the larger trap diameter. Positioning over burrow entrances sometimes meant crayfish could deposit excavated material around the burrow opening without having to travel upwards past the trapdoor. This contrasts with studies in the United States where NTs were inserted directly into burrows (Norrocky 1984; Welch and Eversole 1996; Ridge *et al.* 2008). Testing of a NT design of comparable size to the *Engaeus* burrows targeted in this study would help clarify whether trap size, rather than trap type, influenced capture. Trap materials may have also influenced capture rates. The modified trap was constructed from corrugated hose which is likely to provide a better climbing surface crayfish entering into the trap body than the smooth PVC surface of the NT.

The low capture rates are most likely a reflection of the limited surface activity of *Engaeus* species. Our trap trials occurred in late summer and autumn. Trapping in the generally wetter spring months may improve *Engaeus* capture rates (Morey and Hollis 1997) as this is also likely to coincide with increased surface activity during the mating season (Van Praagh, pers. comm. 2011, Invert-Eco). The high capture rate recorded at Mirboo North site 3 may be associated with the wet conditions at the time of sampling.

Prior to this study, non-destructive sampling methods for the burrowing crayfish genus *Engaeus* had been poorly investigated and used. To date, use of the modified trap has resulted in the capture of ten *Engaeus* species (three species in this study; seven species in studies by D. Crowther and P. Fairbrother, pers. comm. 2012, Arthur Rylah Institute, Department of the Environment and Primary Industries). These results demonstrate the effectiveness of this trap design for *Engaeus* capture and its potential for capturing other burrowing crayfish. We envisage that the outcomes of this investigation will promote wider use of non-destructive sampling methods for *Engaeus*.

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